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PRE-APPEAL BRIEF REQUEST FOR REVIEW

Docket Number (Optional): ARL 01-37

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on ______________________

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Typed or printed name ______________________

Application Number	Filed
10/628,424	7/29/2003

First Named Inventor: Jeffrey A. Read

Art Unit	Examiner
1795	RHEE, JANE J.

Applicant requests review of the final rejection in the above-identified application. No amendments are being filed with this request.

This request is being filed with a notice of appeal.

The review is requested for the reason(s) stated on the attached sheet(s).
Note: No more than five (5) pages may be provided.

I am the

- [ ] applicant/inventor.
- [ ] assignee of record of the entire interest. See 37 CFR 3.71. Statement under 37 CFR 3.73(b) is enclosed. (Form PTO/SB/96)
- [x] attorney or agent of record. Registration number 29503.
- [ ] attorney or agent acting under 37 CFR 1.34.
  Registration number if acting under 37 CFR 1.34 ______________

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February 24, 2009
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NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below*.

- [ ] *Total of ________ forms are submitted.

STATEMENT IN SUPPORT OF PREAPPEAL BRIEF CONFERENCE

In the Office Action dated December 12, 2008, claims 13 -17 were rejected under 35 U.S.C. 103(a) as being unpatentable over Abraham et al. (US 5510209) (Abraham '209) in view of Narang et al (US6991876) (Narang '876). The Office action states:

> As to claims 13-17, Abraham et al. discloses a lithium oxygen battery comprising an electrolyte solution, the battery comprising a lithium metal containing anode (col. 2 lines 21-33), a cathode comprising carbon (col. 2 lines 33), the electrolyte comprising a lithium salt LiPF6 (col. 3 lines 6), and a non-aqueous solvent comprising ethylene carbonate (col. 3 line 7).
>
> Abraham fail to disclose a nonaqueous solvent having an oxygen solubility of greater than 0.1632 02/cc solvent at STP consisting of DMC, DPC, DEC, EMC, THF, or DME.

It is respectfully submitted that the above rejection is not correct and should be withdrawn for the following reasons.

The present invention represents an improvement over Abraham '209 in that the molecular oxygen diffusion is significantly better in high oxygen solubility, low viscosity solvents as opposed to the high viscosity (polymer) low solubility (propylene carbonate) electrolytes disclosed in Abraham '209. Due to increased oxygen solubility, the present invention represents a substantial improvement on the Li/O2 battery of Abraham '209. In conventional batteries such as that disclosed in Abraham '209, the conventional wisdom has held that such batteries should have a very high dielectric constant so they can effectively solvate electrolyte salts so as to provide for ionic conductivity, and that they have high boiling points. Abraham '209 discloses a lithium –oxygen battery which meets this criteria. See specification at paragraph [0005]. Specifically, Abraham '209 at Col. 3, lines 15-30, states:

> Li salts and solvents suitable for preparing the electrolytes of this invention are preferably selected on the basis of the same principles used for selecting these components for highly conductive liquid electrolytes. These requirements include: 1) Li salts having large anions and low lattice energies such as $LiClO_4$, $LiAsF_6$, $LiBF_4$, $FiCF_3SO_3$, $LiPF_6$ and $LiN(CF_3SO_2)_2$; 2) organic solvents with high dielectric constants to promote the dissociation of the low lattice energy Li salts, thereby forming highly conductive electrolyte medium; 3) organic solvents having electron donor atoms such as O and N through which the solvents can

> form complexes (or solyates) with the Li ions of the Li salt. These requirements are realized with Li salts such as $LiClO_4$, $LiPF_6$, $LiN(SO_2CF_3)_2$ and $LiAsF_6$, and organic solvents such as [propylene carbonate] PC and [ethylene carbonate]EC with dielectric constants of 64.4 and 89.6, respectively.

In contrast to the high viscosity (polymer) low solubility (propylene carbonate) electrolytes disclosed in Abraham '209, the present invention is directed to high oxygen solubility, low viscosity solvents. Specifically, claim 13 recites:

> Claim 13 (previously presented): An electrolyte solution for a metal-oxygen battery, the electrolyte comprising:
> a lithium salt selected from the group consisting of $LiPF_6$, $LiBF_4$, $LiClO_4$, $LiC(SO_2CF_3)_3$, $LiN(SO_2CF_3)_2$, $LiO_3SCF_2CF_3$, $LiO_3SC_6F_5$, LiO_2CCF_3, $LiP(C_6H5)_4$, $LiCF_3SO_3$;
> - a non-aqueous solvent selected from the group of solvents having an oxygen solubility of greater than 0.1632 cc O_2/cc solvent at STP consisting of dimethyl carbonate (DMC), dipropyl carbonate (DPC), diethyl carbonate (DEC), ethyl methyl carbonate (EMC), tetrahydrofuran (THF), and 1,2-dimethoxyethane (DME), in combination with one or more solvents having an oxygen solubility of less than 0.1150 cc O_2/cc solvent at STP selected from a group consisting of propylene carbonate (PC), ethylene carbonate (EC), and γ-butyrolactone (γ-BL);
>
> wherein the oxygen solubility of the solvent combination is at least 0.1150 cc O_2/cc at STP; and
> wherein oxygen is reduced at a cathode surface of the metal-oxygen battery to produce O^{-2} or O_2^{-2} ions and an increase in the amount of dissolved oxygen in the electrolyte increases the specific capacity of the cathode.

The electrolyte of the present invention as claimed in claim 13 comprises a non-aqueous solvent having an oxygen solubility of greater than 0.1632 cc O_2/cc solvent at STP in combination with one or more solvents having an oxygen solubility of less than 0.1150 cc O2/cc solvent at STP selected from a group consisting of propylene carbonate (PC), ethylene carbonate (EC), and γ-butyrolactone (γ-BL) *wherein the oxygen solubility of the solvent combination is at least 0.1150 cc O2/cc at STP.*

Narang '876 does not disclose the concept of the present invention. Narang '876 is not directed to a metal-oxygen (or lithium oxygen) battery and the battery disclosed in Narang '876 functions in a different manner. Narang '876 is directed to a battery containing "an active oxygen-containing cathode" (see Col. 3, lines 50-55). Narang '876 states:

> With respect to the cathode material, is contemplated that the *cathode material* comprises any material that includes an *active oxygen species* ionically or covalently bound to a metal, carbon, silicon or other suitable element. The term "active oxygen species" as used herein refers to a reactive O_2^- and O_2^{2-}. [*Emphasis added*]

Col. 4, lines 64-67.

> Suitable inorganic compounds and materials for cathode materials are those that comprise an active oxygen species or the ability to generate an active oxygen species . . . .
> In yet further alternative species, cathode materials may also comprise metal peroxides or superoxides, such as lithium peroxide, sodium peroxide, lithium superoxide, sodium superoxide, etc.

Col. 5, line 62 – Col. 6, lines 3-10.

During the operation of the battery of Narang '876, the cathode reaction (as stated at Col. 8, line 46, et seq.) ***begins*** with lithium peroxide as the cathode material:

$$Li_2O_2 + 2e^- + 2\ Li^+ \rightarrow 2\ Li_2O$$

In contrast, the metal oxygen battery claimed herein, as stated in the '967 Patent, functions in a different manner:

> During the discharge of the [lithium-oxygen battery] cell, oxygen is reduced at the electro-active cathode to produce O^{-2} and O_2^{-2} ions which react with the lithium to ***produce*** Li_2O_2 and/or Li_2O. . . .

[***Emphasis added***]. It would be incongruous to modify the battery of Abraham as suggested by the Examiner since the battery disclosed in Narang '876 is a different type of battery that functions in a different manner. Although the Office action states that the combination of Abraham '209 and Narang '876 would be made "in order to allow the battery to operate at higher voltages and avoid parasitic reactions," in view of the fact that the reactions are dissimilar, no basis is seen for the above conclusion. Moreover, assuming, *arguendo*, that one could combine Abraham '209 and Narang '876 as suggested by the Examiner, there is no showing that the modified Abraham battery would function as proposed by the Examiner. Abraham '209 is directed to a metal oxygen

battery in which different chemical reactions occur. It is axiomatic that one cannot use hindsight to pick and choose elements of the prior art with no apparent justification.

Moreover, as stated in the request for reconsideration filed on September 4, 2008:

> U.S. Patent No. 6,991,876 to Narang, et al, issued from U.S. Patent Application Publication No. 20040091774 (Narang '774 Publication), which was previously withdrawn as a reference.

In the Office Action dated August 30, 2006, claims 13-17 were rejected under 35 U.S.C. 102(e) as being anticipated by the Narang '774 Publication. In the Office Action dated April 6, 2007, the rejection of claims 13-17 as being anticipated by the Narang '774 Publication was withdrawn "due to applicant's affidavit filed on 2/28/2007." It is respectfully requested that the rejection of claim 13 be withdrawn and that the claim be deemed allowable.

Claim 14 recites

> A metal-oxygen battery comprising:
> a metal-containing anode;
> a cathode for reducing the oxygen;
> an electrolyte solution of a lithium salt selected from the group consisting of $LiPF_6$, $LiBF_4$, $LiClO_4$, $LiC(SO_2CF_3)_3$, $LiN(SO_2CF_3)_2$, $LiO_3SCF_2CF_3$, $LiO_3SC_6F_5$, LiO_2CCF_3, $LiP(C_6H5)_4$, $LiCF_3SO_3$;
> - a non-aqueous solvent for the electrolyte selected from the group of solvents having an oxygen solubility of greater than 0.1632 cc O_2/cc solvent at STP consisting of dimethyl carbonate (DMC), dipropyl carbonate (DPC), diethyl carbonate (DEC), ethyl methyl carbonate (EMC), tetrahydrofuran (THF), and 1,2-dimethoxyethane (DME), in combination with one or more solvents having an oxygen solubility of less than 0.1150 cc O_2/cc solvent at STP selected from a group consisting of propylene carbonate (PC), ethylene carbonate (EC), and γ-butyrolactone (γ-BL);
>
> wherein the oxygen solubility of the solvent combination is at least 0.1150 cc O_2/cc at STP; and
> wherein oxygen is reduced at a cathode surface of the metal-oxygen battery to produce O^{-2} or O_2^{-2} ions and an increase in the amount of dissolved oxygen in the electrolyte increases the specific capacity of the cathode.

Inasmuch as claim 14, includes, *inter alia*, the limitation that "an increase in the amount of dissolved oxygen in the electrolyte increases the specific capacity of the cathode," claim 14 is allowable over the Abraham '209 alone or in view of Narang '876. Claim 15, which depends on claim 14, is similarly patentable over Abraham '209 alone or in view of Narang '876.

Claim 16 recites:

16. A lithium-oxygen battery comprising:
a lithium metal-containing anode;
a cathode for reducing oxygen;
an electrolyte solution of a lithium salt selected from the group consisting of $LiPF_6$, $LiBF_4$, $LiClO_4$, $LiC(SO_2CF_3)_3$, $LiN(SO_2CF_3)_2$, $LiO_3SCF_2CF_3$, $LiO_3SC_6F_5$, LiO_2CCF_3, $LiP(C_6H5)_4$, $LiCF_3SO_3$; and

- a non-aqueous solvent selected from the group of solvents having an oxygen solubility of greater than 0.1632 cc O_2/cc solvent at STP consisting of dimethyl carbonate (DMC), dipropyl carbonate (DPC), diethyl carbonate (DEC), ethyl methyl carbonate (EMC), tetrahydrofuran (THF), and 1,2-dimethoxyethane (DME), in combination with one or more solvents having an oxygen solubility of less than 0.1150 cc O_2/cc solvent at STP selected from a group consisting of propylene carbonate (PC), ethylene carbonate (EC), and γ-butyrolactone (γ-BL);

wherein the oxygen solubility of the solvent combination is at least 0.1150 cc O_2/cc at STP; and
where oxygen is reduced at a cathode to produce O^{-2} or O_2^{-2} ions which react with lithium to produce Li_2O_2, that deposits on the cathode.

As explained in the foregoing, Abraham '209 alone or in combination with Narang '876 does not disclose the limitation wherein the oxygen solubility of the solvent combination is at least 0.1150 cc O_2/cc at STP. Accordingly, claim 16 is allowable. Claim 17 depends on claim 16 and is thus allowable for the reasons applicable to claim 16.

Respectfully submitted,
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